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ABSTRACT

Objectives for this module include the ability to: (1) order objects by comparing a property which the objects have in common (such as length, area, volume or mass), (2) describe objects (length, area, volume, mass, etc.) by comparing them quantitatively using either arbitrary units of comparison or standard units of comparison, and (3) describe objects by making quantitative estimates of their dimensions. The general pattern of instruction is one of presenting the situation with as little instructor-direction as possible. After the participants have generated the data, then the sequence provides illustrations of how the instructor could guide the discussion toward a meaningful interpretation of the data gathered. The instructional component of the module consists of: Materials List, Pre-Appraisal, Instructional Activities, and Post-Appraisal. Also included are performance objectives, references, rationale, and duplicated materials. Because of the diagnostic data available in the pre-appraisal experience, it is possible to determine which instructional sequence appears to be most appropriate for which student. The time periods required for this instructional module are three hours of planning and 130 minutes of teaching. The population for which this instructional program has been found to be effective includes preservice and inservice elementary school teachers. (BR)

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COMPARING OBSERVATIONS

1st Experimental Edition

The Research & Development Center
For Teacher Education

THE UNIVERSITY OF TEXAS
AUSTIN

SE 008 228

ED037370

MAR 27 1970

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COMPARING OBSERVATIONS

1st Experimental Edition

Table of Contents

	Page
Objectives	1
Rationale	1
References	5
Materials List	6
Instructional Activities	9
Duplicated Materials -- Without Answers	25
Duplicated Materials -- With Answers	44

COMPARING OBSERVATIONS

David P. Butts

Science Education Center
and
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The University of Texas at Austin

I. PERFORMANCE OBJECTIVES:

At the end of this session the participants should be able to:

1. Order objects by comparing a property which the objects have in common (such as length, area, volume or mass).

2. Describe objects (length, area, volume, mass, etc.) by comparing them quantitatively using either arbitrary units of comparison or standard units of comparison.

3. Describe objects by making quantitative estimates of their dimensions.

II. RATIONALE:

In perceiving objects or events, it soon becomes desirable - because of sheer quantity,indeed essential - to contrast or compare the observations in order to consider similarities or differences. Intuitively, these comparisons are made in terms of specific properties of the object or event, which seem to be held in common contrast. To compare a glass of ice tea with a cup of hot tea, comparisons could be made of color (brown), phase of matter (liquid), or amount (volume). Usually, however, when the two substances are compared, temperature will probably be the property selected.

To describe a contrast, observation of specific properties are essential. To refine observations, it is necessary to say more than the hot tea is warmer than the other; or equally accurate, the ice tea is cooler than the hot tea. In either case, it is relevant to know that neither substance is hot or cold; that is, one substance is compared with the other and it is hotter or colder based on this comparison. When compared with dry ice, the ice tea would, of course, be warmer. Establishing a frame of reference for the comparison (that is identifying with what the object or event is being compared) is one way in which observations are extended.

Even though a frame of comparison has been established, in order to extend the observations of the two tea substances the five senses are inadequate to distinguish the temperature differences. Now it is essential to have a means by which smaller differences can be detected and these differences contrasted. Throughout the history of science, creative men have constructed instruments to aid the five senses in comparing. These instruments are now highly refined and serve as very useful means to aid in extending the five senses.

However, instruments as a means for securing comparative data present a concern--communication. Although scaling the comparison is an arbitrary choice, communicating the scale to another individual is necessary, for the scale and divisions to be meaningful. Thus, the fascinating history of linear scales, temperature scales, etc. has developed. Once a common scale has been made, the task of communicating with others is a simpler one.

Extending observations through comparisons, or contrast, or against scales that have common acceptance (standards), describes the task of MEASURING. Inherent in this task is the decision as to what type of comparison to make and what instrument to use.

The instructional activities of this module are based on the sequence described in Figure 1.

The general pattern of instruction in this module is one of presenting the situation with as little instructor-direction as possible. After the participants have generated the data, then the sequence provides illustrations of how the instructor could guide the discussion toward a meaningful interpretation of the data gathered.

Because of the diagnostic data available in the pre-appraisal experience, it is possible to determine which instructional sequence appears to be most appropriate for which student. Experience indicates that if 80 percent of a group performs well on an appraisal task, the related instruction activities should be omitted. For this instructional module, this is illustrated as:

Objective	Appraisal Task	Instructional Activity
1	I and II	1
2	III, IV and V	2 and 3
3	VI	4, 5, and 6

OBJECTIVES:	Order objects by comparing a property which the objects have in common.	Describe objects by comparing them quantitatively using either arbitrary units of comparison or standard units of comparison	Describe objects by making quantitative estimates of their dimensions.
POST APPRAISAL	I and II	III, IV and V	VI

Activity VI

- Construct an operational definition of the task of measurement.
- Apply a rule for determining the volume of objects

Activity V

- State a rule for determining the volume of a group of objects
- Order a group of objects based on volume

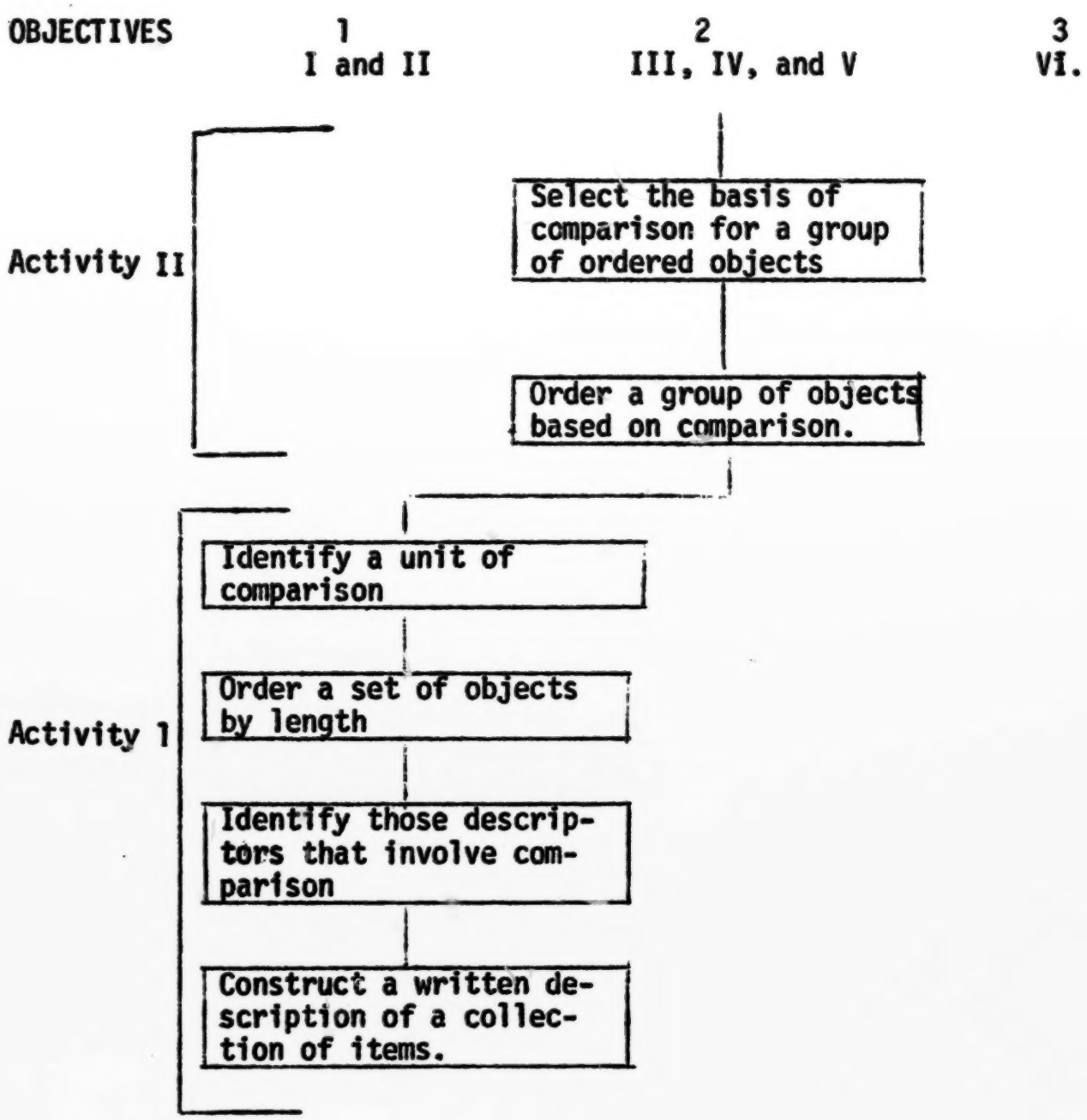
Activity IV

- Demonstrate the use of that unit of mass comparison
- Identify the unit of comparison
- Order a group of objects based on mass

Activity III

- Describe the comparison of linear measurement using a standard unit
- Identify the unit of measure most appropriate for the comparison being made.
- Describe the comparisons between objects using linear dimensions as basis of comparison

Figure I - Continued


OBJECTIVES
1
I and II
2
III, IV, and V
3
VI.
Activity II
Select the basis of comparison for a group of ordered objects
Order a group of objects based on comparison.
Activity 1
Identify a unit of comparison
Order a set of objects by length
Identify those descriptors that involve comparison
Construct a written description of a collection of items.

Pre-Appraisal Task	I-II	III, IV and V	VI

Evaluation Data:

The population for which this instructional module has been found to be effective includes preservice and inservice elementary teachers who teach science.

The results of students involved in the instructional experience as described in this module are as follows:

The time periods required for the instructional module include:

A. Planning for instruction: about 3 hours.

B. Teaching: 130 minutes.

Suggested time periods for the module are as follows:

A.	Pre-Appraisal	25 minutes
B.	Activity I	10 minutes
C.	Activity II	10 minutes
D.	Activity III	20 minutes
E.	Activity IV	20 minutes
F.	Activity V	10 minutes
G.	Activity VI	10 minutes
H.	Post-Appraisal	25 minutes
	TOTAL	130 minutes

III. REFERENCES:

Commission on Science Education. Science - A Process Approach, Commentary for Teachers. AAAS Miscellaneous Publications, 6S-22, 1968, pp. 102-111, 244-253.

Cusack, Michael, "The Long and the Short of It," Science World, 17 (1), 18-20, 25. (Bound in Scholastic Teacher, September 13, 1968).

DeRose, James V. "What Does It Mean to Measure?" Science and Children, April, 1967.

Lemmon, Robert A. "Quantitative Descriptions in Science, " Science and Children, December, 1965.

Leonard, Edward H. "A Modified Meter Stick", Science and Children March, 1966.

Swan, Malcolm D. "How Long is '100 feet'?" Science and Children December, 1966.

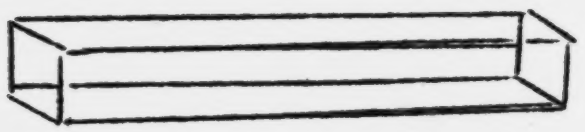
IV. MATERIALS LIST

Pre-Appraisal	CO# 1 (1 per participant) Ruler (1 per participant)	
Activity 1	Packet A (1 per participant)	An envelope of three (3) straws (1 is 1 unit long, 1 is 2 units long, and 1 is 4 units long.)
Activity 2	Packet B (1)	Set of containers - (5 dram vial, 13 dram vial, 30 dram vial)
Activity 3	A Stick (1) B Stick (1) C Stick (1) Meter sticks (1 per 2 participants) Graph paper - 1 per 2 participants)	unmarked meter stick unmarked decimeter stick unmarked 1 cm cube
Activity 4	Packet C (1)	Set of 6 spheres - 2" styrofoam ball; 1" styrofoam ball; 1" marble; plastic ping pong ball; plastic golf ball; real golf ball; 2" rubber ball; 1" rubber ball - or Set of 6 cylinders - 2 cm in diameter - 1 aluminum, 1 steel, and 1 plastic - 8 cm in length; 1 aluminum, 1 steel, and 1 plastic - 5 cm in length.
	Equal arm balances Straight pins	1 per 2-5 participants
	Packet D	2" rubber ball, or (cylinder is alternative object) and package of measuring units such as clips, small nails, buttons, beans, tacks, etc. Each group has a set of different measuring units.

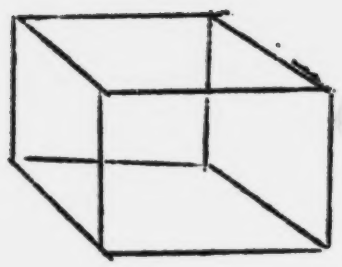
Activity 4 - Cont.		
	Set of gram masses (optional)	1 per 2-5 participants
Activity 5	Packet E	1 per 2-5 participants Set of 5 blocks -(see sketch attached.) 1 cm^3 cube must be of a material so that it will sink in water.
	Rulers	1 per 2-5 participant
	100 m.l. graduated cylinder	1 per 2-5 participants
Activity 6	CO# 2	1 per participant
	Rulers	1 per participant
Appraisal	CO#3	1 per participant
	Rulers	1 per participant
	CO# 4	1 per participant

PACKET E- Set of Five Block

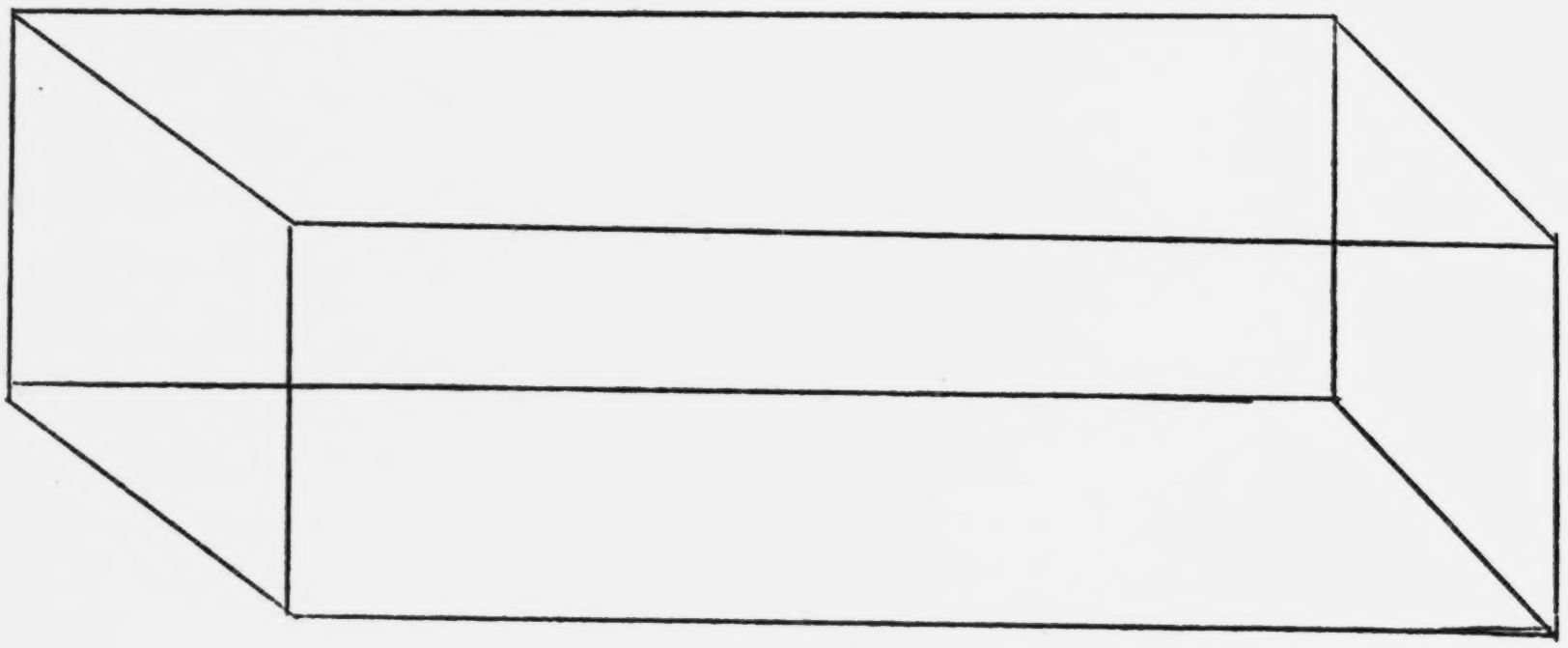
1 cm^3
(aluminum)



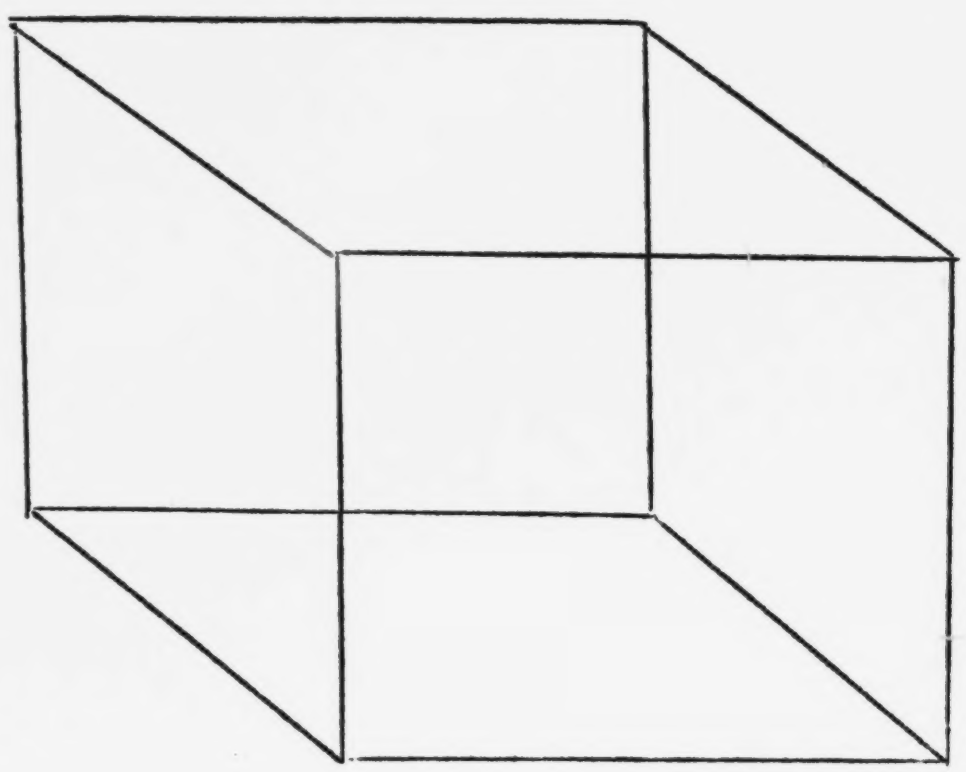
1 cm x 10 cm x 1 cm
(Aluminum)



2.5 cm^3 (1 inch cube)
(wooden)



5 cm x 5 cm x 10 cm - (styrofoam)



5 cm^3OR 10 cm^3 -(styrofoam)

V. INSTRUCTIONAL ACTIVITIES

Pre-Appraisal (Approximate time - 25 minutes)

(Directions: Distribute CO#1, the Pre-Appraisal.)

1. Communicating our experience to others is a task in which we have all been involved. Precision in this communication we may have found useful. Here are 7 tasks that involve this communication. You will have 10 minutes to complete them. After you have finished, we will review the responses, to identify those tasks we do well and those with which we need further assistance.

After 20 minutes, move on to the next step.

2. The acceptable responses for each task are: (see CO# 1 with answers.)

If you name two of the properties circle Task I.
Length, width, area, perimeter, number of angles.

If you had this order for Task II circle it.
F, A, B. C. D, E.
C, B, F, E, D, A.

If you listed three of these possibilities circle Task III.
Height, weight, area, number of leaves, area of leaves.

If you had a description like this, circle Task IV.
2 times as tall as third day plant,
1/2 as tall as 6 day plant,
6 times as tall as second day plant.

If you had a description like this circle Task V.
6-5/8 inches in height,
16-1/2 centimeters in height.

If your estimates were Numbers 1, 5, 8 and if you circled the third line, then circle Task VI.

Check the responses, Tally the number of those who did the individual task correctly, as follows:

Task	No. Having Acceptable Responses
I	
II	
III	
IV	
V	
VI	

Based on their responses, select those activities of the module, which are needed for the participants. You and they now have a clear diagnosis of which activities are needed as learning activities. Acceptable performance is 80% of the group performing the task. You may wish to omit the corresponding activity. For those tasks in which performance is less than 80%, the activities related to that task should be included in the session. The following table illustrates the relationship between the pre-test task, objective, and activity.

Correlation of Objectives, Pre-Appraisal Tasks, and Instructional Activities.

Objective	Task	Activity
1	I and II	1, 2
2	III, IV, and V	3, 4, 5
3.	VI	6

Activity 1 - (Instruction time: approximately 10 minutes)

Objective 1: Order objects by comparing a property which the objects have in common (such as length, area, volume or mass)

(Direction: Distribute Packet A.)

3. Each of you have received an envelope of objects. Please take them out of the envelopes and write a description of these objects. You have three minutes to do the task.

As the participants are writing, observe the kinds of comments they are writing about the drinking straws.

4. _____ please read your description.

Have several share their descriptions. As they do this, write on the chalkboard only those descriptions which are comparative: Length, diameter, pliableness, etc.

5. As you have been sharing your descriptions, I have constructed a list on the chalkboard. To put a heading on this list, in what way are all of these alike?

Here you have focused on the properties of the object - but more than that, properties that have been compared. An acceptable heading then would be

COMPARISONS

6. Look at your descriptions and circle each one that you either did compare or that you could compare. Let's add these to the list.

You will now have a rather impressive list of possible ways in which the straws could be compared. You may wish to note that for some of these comparisons, scales exist. For others, the scales may exist and are unfamiliar, or for some they may not even exist.

7. Suppose we select one of these bases for comparison: length. Order your straws by length.

Observe the results. Some may order them from longest to shortest or shortest to longest.

8. Which straw did you use as your basis of comparison?

Some may have used the longest straw as the basis and others may have used the shortest.

9. Describe the other straws using your basis.

Here the descriptions will either be the straw is twice as long, or four times as long, or one-half as long and one-fourth as long.

10. Does it make any difference which unit you use as a basis: the longest or shortest?

At this point, it may be the general agreement of the group that it really does not make any difference as to which unit is used. Accept this ooncensus: Whatever unit is convenient, probably is appropriate to use. (Note: Later activities will extend this idea by illustrating the inconvenience of using the largest unit for comparison. Also, employing the smaller objects as a basis avoids the need for using fractions.)

Activity 2 (Instruction Time: Approximately 10 minutes)

Objective 1. Order objects by comparing a property which the objects have in common (such as length, area, volume or mass).

(Directions: Display the set of containers from Packet B)

11. Here is a set of containers; which will hold the most water? Which one the least water?

If there is agreement concerning the least and the most, move on to the next step. If there is disagreement, you may wish to stop and have the various members demonstrate how they could find out which holds the most and which holds the least.

12. _____ will you please order these containers from that which will hold the least to the most water? What did you use to make your decision?

Here you have the opportunity to observe how the participants would support their choice. Did they use the largest or the smallest container as their basis of comparison?

13. Suppose you use the largest one as your basis of comparison. Show me how you could use it and the water to order the containers according to how much water they will hold.

The difficulty inherent in using the largest container will become obvious. The participant may pour water from the smaller to larger containers and then mark the smaller amount on a larger container - in reality, using a fraction of the large container as the unit of comparison.

14. Now use the smallest container as the unit of comparison.

15. Describe the difference between the two tasks, and how were these tasks like the straw task?

It is more efficient to describe in terms of small units.

Activity 3 (Teaching Time: Approximately 20 minutes)

Objective 2: Describe objects (length, area, volume, mass, etc.) by comparing them quantitatively using either arbitrary units of comparison or standard units of comparison.

(Directions: Use Stick A, unmarked meter stick)

16. I have a stick. What do you think I can do with it?

Accept all responses; however, you will probably have several dealing with measuring.

17. Tell me how many sticks long this chalk tray is?

The response may be that it is about 2-1/2 sticks long.

18. Since you don't have any half sticks, how many of these sticks long is the chalk tray? Is it exactly 2 sticks long - or between two and three sticks long? If between two and three sticks long, is it closer to 2 or closer to 3? Then we can say, it is about 2 sticks long.

Repeat for 2 or 3 objects in the room - height of door, window, height of desk, etc. Emphasize the between-number-of sticks idea and the description in terms of about how many sticks long the object is.

19. Now will you tell me how many sticks wide the desk is?

Since the desks will probably be less than one stick, you will want to emphasize the description as being between 0 and 1 sticks wide, but closer to 1 than to 0, hence about 1stick wide.

20. How many sticks wide is your paper?

It will be obvious that it is between 0 and 1 sticks wide, but closer to 0 than to 1,hence it is about 0 sticks wide.

21. That means you don't have any paper?

Not really, of course, but you are working toward the need for a smaller unit.

22. If you believe that you do have paper there, and that it does have length, but you have described it as being 0 sticks long what can you do about making your description more precise?

Listen carefully for responses. The <u>one</u> <u>solution</u> is to secure a smaller stick.

(Directions: Use Stick B, unmarked decimeter stick.)

23. You think your description could be more precise if you had a smaller stick? Good! I just happen to have one here. Tell me now how many sticks long the paper is?

You may wish to have them also use the stick for 1 or 2 other lengths, such as the desk top, arm length, etc.

24. Please draw the outline of your hand and fingers. Using this stick, how many units long is a line drawn from the wrist to the top of your second finger?

For most adults this is about 2 units long. Again, it is wise to emphasize that it may not be exactly 2 units but between 2 and 3 units, but closer to 2 than 3, hence the line is about 2 units long.

25. Now, how many units wide is your second finger?

Here it will be between 0 and 1 units wide, but closer to 0 than to 1

(Directions: Use Stick C, unmarked 1 cm cube.)

26. It is about 0 units wide; therefore, you have no finger. What will help you describe the width of your finger?

Again you have created the need for a smaller stick. When called for, you have a cm cube with which the individuals can describe the width of their finger.

27. We have 3 sticks here. How many of the B sticks could be put on the A stick?

Secure estimates from several. They usually range from 7 to 13 B-sticks along the edge of the A-stick. Write the estimates on the chalk board.

28. Will you please check this.

Hand an A stick and a B stick to one of the participants and observe how they go about checking. The results should show that ten B sticks are the same as one A stick.

29. How many of the C sticks could we line up along the edge of the B stick?

Again, secure the responses of the group. You will quite likely have a smaller range - 9 to 11. Have a participant verify the results that 10 C sticks is the same length as 1 B stick.

30 If 10 B sticks is the same as the length of 1 A stick, and 10 C sticks is the same as 1 B stick, how many C sticks does it take to have the length of 1 A stick.

You will have several quick responses of 100. Write this on the board.

1A = 10B = 100C
1B = 10C

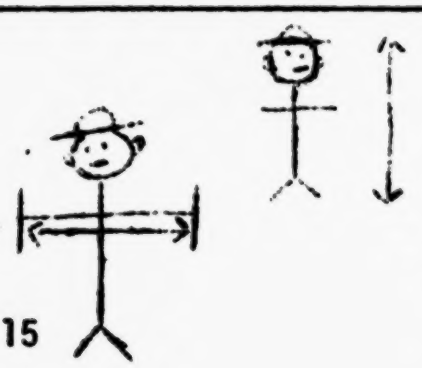
31. Rather than call these by the names of "A", "B", or "C", what names do you think they have?

Depending upon the group, you may have a variety of responses. The easy way to recall both the relationship between the sticks and the names is really a little language drill.

Meter = $1 stick
Deci-meter = Dime stick
Centi-meter = Penny stick or Cent stick.

(Directions: Give each pair of participants a marked meter stick and graph paper included in CO #1.)

32. Now select your partner and measure each other's height. and arm-finger tip width.



You may wish to record the data on the chalk board and then have the participants graph the results, or perhaps the participants will wish to repeat this measuring activity in their classrooms with their pupils and graph the results.

33. What can you now say about comparison of height and finger-tip width?

The obvious conclusion will be that regardless of the height, the finger-tip width is about the same as the height of a person.

Activity 4 (Teaching Time: Approximately 20 minutes)

Objective 2: Describe objects (length, area, volume, mass, etc.) by comparing them quantitatively using either arbitrary units of comparison or standard units of comparison.

(Directions: Pick the two cylinders or spheres most alike in mass and save for Step 35. Display the rest of Packet C, set of four remaining spheres.).

34. Here is a set of objects. Order them and then describe for us the basis for your order.

Ordering the spheres or cylinders can be based on a variety of properties: diameter, volume, color, mass, etc. Have another participant describe the basis on which the spheres were ordered, and then check the initiator who did the ordering to see if this basis has been accurately described. If no one uses mass or heft as the basis, order them using it as a comparison, and have the group describe your comparison.

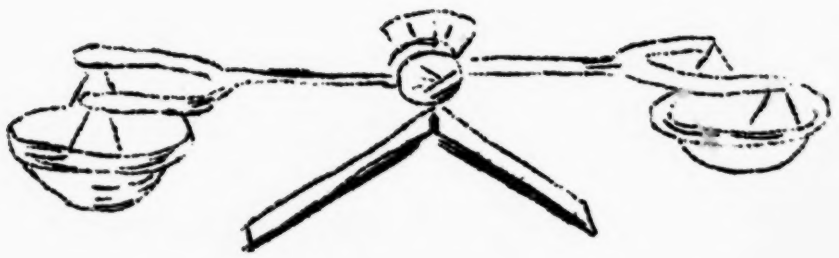
(Directions: Now show the two spheres or cylinders most alike in mass you reserved from above.)

35. In what position would these two objects be placed?

Secure opinion of each person as to which of the two spheres or cylinders have the greater mass. Record how many pick which object and how many say the two objects have the same mass and how many say they can't tell. The point here is that many times we reach the limitations of our senses and must have additional tools for distinguishing the similarities and differences in our environment.

36. What tools should we use to find out where they should be placed?

The variety of measuring tools available to us to use in this instance will require that we select the tools appropriate to our tasks. In this instance the tool must be a way of comparing masses of the two objects. Scales to weigh the objects may be suggested but recall that weight is a force. What we want to compare is the mass of these two objects. When using an equal-arm balance we are not weighing but we are comparing the earth pull on the masses.



(Directions: The instructor is demonstrating with one balance before the group.)

Assemble the base and arms of the balance. Place one hand on the right side of the balance.

37. When I push down on this side what will happen to the other side of the balance? When I push down with the same push on both sides, what happens.

At this point, have the participants identify those situations where we have the same push on both sides of the balance and describe how they know, that is, by the inclination on the arm of the balance.

(Directions: place the reserved spheres on the balance.

38. If the objects have the same mass, what might we expect if they are placed on the balance?

If the mass or stuff in each object is the same, then there will be the same push on both sides of the balance. The balance will not be inclined.

Note: We are not weighing the objects but we are comparing pushes. You may wish to extend this idea that it is an indication of the relevant amount of earth pull on the stuff in the objects.

(Directions: Have available a number of straight pins.)

39. What must we do to find out how much more push one object had than the other?

Accept all suggestions and have participants try each suggestion. One way that is useful is to add stuff to the object that has the smaller mass until the balance is equal.

40. How much more stuff does one object have than the other?

In the previous question we determine how much additional stuff was needed to balance the scales. We were able to describe the additional stuff in terms of pins and etc. If we now put only pins in one of the pans, we can then describe the total stuff of each object in terms of pins.

(Directions: Give each group a balance and a Packet D)

41. Balance your object and report the results.

Record the results on the chalkboard.

42. Here we have the results of the teams. Why are the results different?

Although they may have been very careful, the pin group cannot intelligently discuss their results with the buttons group, or the buttons group with the rubber bands group. The need for standard units of comparisons can only be satisfied by all people using the same unit.

43. What can we do to facilitate our communications?

By using the same unit of comparison.

44. What unit should be used?

Common agreement among scientists is to use gram masses. You may wish to give each group a set and have them now describe the stuff in the sphere by using the gram masses.

Activity 5 - (Teaching time: 10 minutes)

Objective 2: Describe objects (length, area, volume, mass, etc.) by comparing them quantitatively using either arbitrary units of comparison or standard units of comparison.

(Directions: Give each group a Packet E)

45. Order the blocks.

You will want to observe both the sequence that the participants construct and the way in which they do it.

46. Tell us on what basis did you order the blocks.

List their responses on the board. If no group mentions volume, you order the set of blocks and ask them for your basis.

47. What is the rule for determining the volume of a rectangular solid object like these blocks?

Length x Width x Height.

(Directions: Distribute a ruler to the groups.)

48. Compute the volume of the five blocks.

Record the answers on the board. Notice how many groups give the answer in cubic units.

49. For what reason did you give the answer in cubic units?

An acceptable answer is that when planes are drawn through the object on the three axes it results in blocks shaped like cubes.

50. Point to the results on the chalkboard and ask - what is the way to abbreviate cubic centimeters.

Answers will probably be C.C. Show another notation such as 5 cubic centimeters = 5 c. c. = 5 cm^3. Do all five volumes of the five blocks this way on the board with help from the participants.

(Directions: Use the solid object from Packet D.)

51. What would you do to find the volume of the object which has been given you?

Confusion may exist at this point.

(Directions: Distribute a 100 m. l. graduated cylinder. If water is available, have each group fill theirs to 50 line. If no water is available, have the cylinders filled to the 50 line, in advance.)

52. What is the volume of water in the container?

50 m. l.

53. What does the m. l. stand for?

Milliliters.

54. What is the volume in milliliters of the sphere or cylinder which you have? How can you check it?

The group will probably estimate it and tell you that they can check it by placing the solid sphere or cylinder into the graduated cylinder and taking the difference between 50 m.l. and the water level after the immersion of the cylinder.

55. Check your estimates.

56. What is the volume of the 1 c.c. or 1 cm^3 in milliliters? Check it.

This is the smallest cube in Packet E. They will find that 1 c.c. is equal to 1 m.l.

57. What is the volume in m. l. of the five blocks?

This can be expanded on the board because you already have:
1 cubic centimeter - 1 c.c. = 1 cm^3 --- 1 m.l.
Complete the data on the board. You may wish to add information of c.c. used in medication.

Activity 6 (Teaching Time: 10 minutes)

Objective: Describe objects by making quantitative estimates of their dimensions.

(Directions: Use CO#2.)

58. We have been dealing with common properties of various objects. Suppose you do not have a unit of comparison but you wish to estimate how long it is. Complete the exercise.

Distribute rulers so that participants may check their results.

59. At this point let us define the skill of comparing observations or measuring. Write down a definition for the following term. Write on the board:

Observation = description of properties of objects or events based on perception of senses.

Measuring =

An acceptable definition of measuring should include the idea of --

a. A comparison or contrast of a specific property;
b. A standard for that comparison;
c. A description of how many units of that standard.

Appraisal: (Time: 25 minutes)

60. To check up on how well you have done, here is a learning diagnosis sheet. You will have 20 minutes in which to respond. At the end of this time we will review the responses.

When the task is completed, give immediate feedback to the participants by providing acceptable responses. Tally the results of the group, as for the Pre-Appraisal. You may wish to have participants compare their own pre-and post appraisals. If additional help is needed, individuals may be referred to supplementary material in the Commentary for Teachers - (Science - A Process Approach). See references.

61. Check your responses - if you have this order for Task I, circle it.

G, E, A, C, B, D, F
E, C, F, D, A, B, G

If you named two of these properties circle Task II.

Height, Width, Area, Age.

If you listed three of these possibilities circle Task III

Height, Width, Area, Age.

If you had a description like this circle Task IV.

3 x height of 1 week
2 x width of 1 wee
6 x area of 1 week
5 x older and age.

If you had a description like this circle Task V.

4 centimeters tall
4 centimeters wide

If your estimates were 3 centimeters, 6 centimeters, 10 centimeters, and if you circled the second line, circle Task VI.

Correlation of Objectives, Appraisal Tasks, and Instructional Activites

OBJECTIVE	TASK	ACTIVITY
1	I and II	1, 2,
2	III, IV, V	3, 4, 5,
3	VI	6

If time and interest permits, you may wish to follow this with how the comparison of observations or measuring is introduced to children, using CO No. 4.

A possible task is to have the participants show how they would design the introduction of "time" to children and then to compare their sequence with that described in CO. No. 4.

Duplicated Materials -- Without Answers

CO #1

Code_____

Comparing Observations

Pre-Appraisal

Task I. Farmer Brown was planning to build a pen for his pigs. Some alternate plans for his pen are depicted on the following page.

Name two (2) properties common to the pens.

_____

Task II. a. Order the pens on the basis of area.

_____

B. Draw the longest straight line possible inside each pen. Now order the pens on the basis of the lines you drew.

_____

Task III. Attached are sketches of a Mung Bean Plant. Describe three ways the developing plant can be compared on different days.

_____

_____

_____

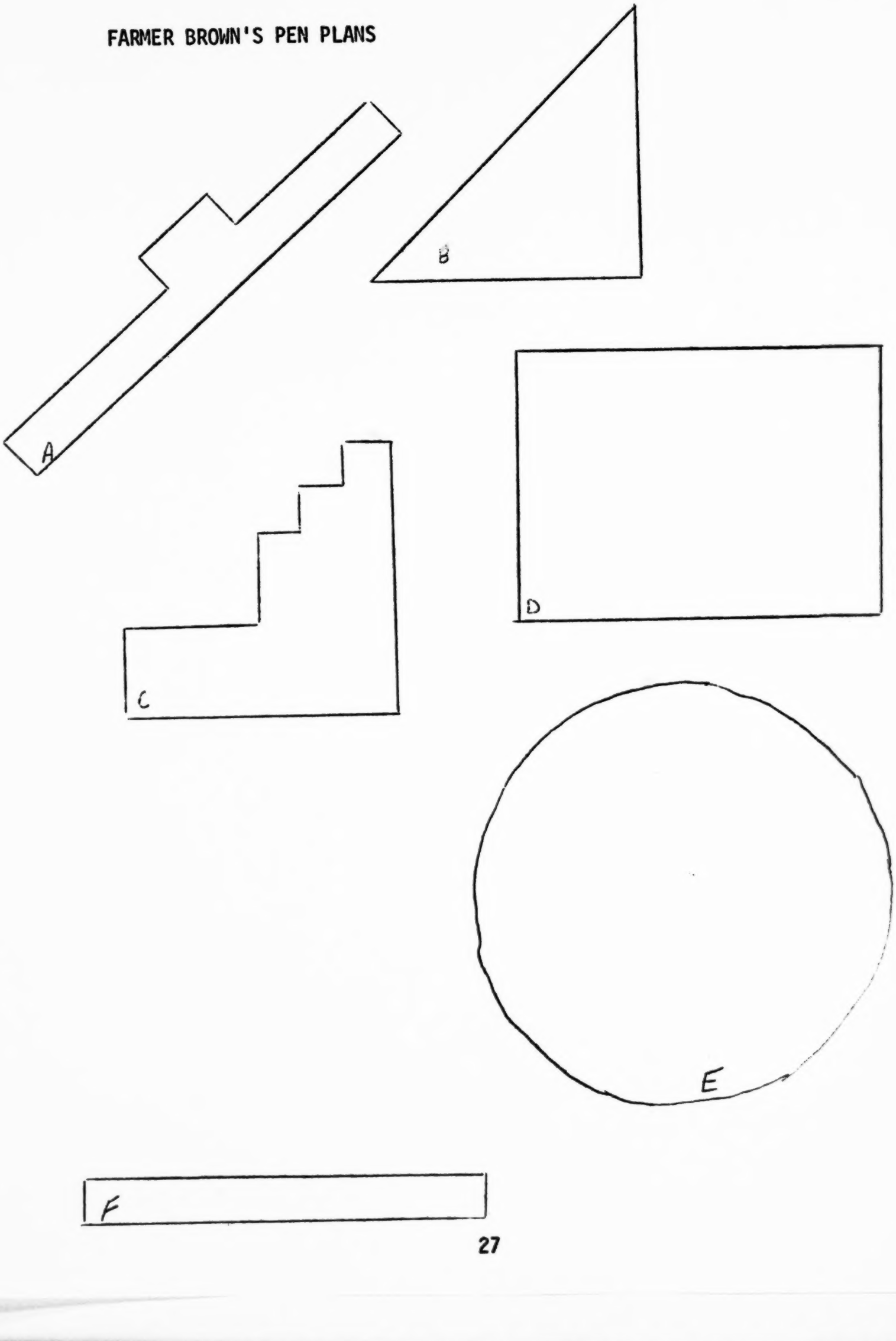
Task IV. Describe the plant on the fourth day, using its appearance on another day as a unit of comparison.

_____

Task V. Describe the plant on the seventh day using a standard unit of comparison.

_____

FARMER BROWN'S PEN PLANS

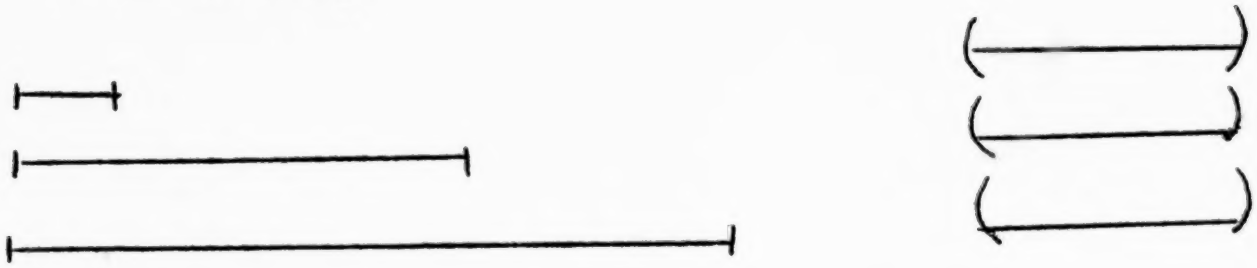


A full scale sketch of a Mung Bean Plant on successive days after planting.

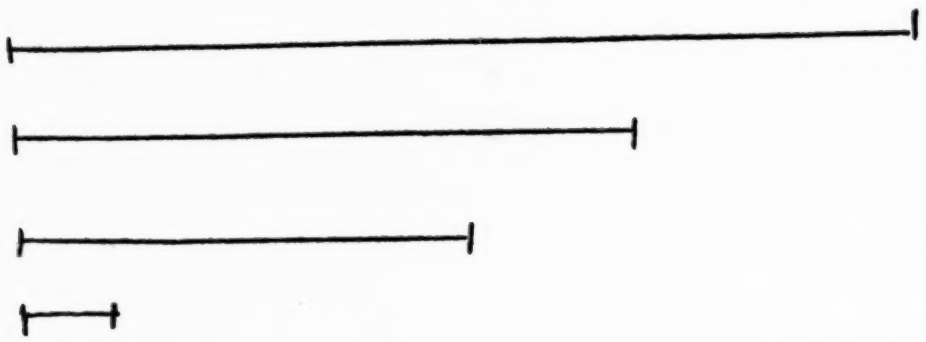
Days after planting.

Task VI. Use only your pencil--no other tools.

The line above is 10 cm in length. Estimate the length of the following:



Which of these lines is closest to 5 cm in length? Draw a circle around it.



Code_____

Use only your pencil--no other tools.

1. Estimate the width of this paper in cm.

_____

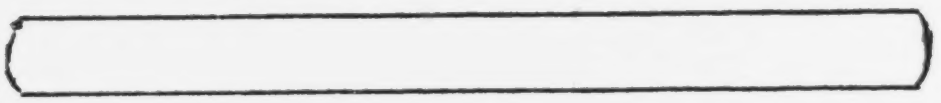
2. There are three types of film: 8 mm, 16 mm, and 35 mm. Mark these lines to show the width of each film.

8 mm _____

16 mm _____

35 mm _____

3. Advertisement is being made about the "silly millimeter" that is being added to cigarettes. Show how much longer this cylinder would be if a millimeter was added.



4. What is the length of your shoe in decimeters?

_____

5. A rock hit an auto windshield and the crack spread out in all directions from the point of impact about 2 cm from the center. Draw a circle the size of the cracked area of the windshield.

Code_____

Comparing Observations

Appraisal

Task I A contractor was planning to subdivide a new area of the county. Some alternate plans for his subdivision appear on the following page.

a. Order the tracts on the basis of the amount of area of each tract.

_____

b. Draw the longest straight line possible inside each tract. Now order the tracts on the basis of the lines you drew.

_____

Task II Attached are sketches of a leaf. Name two properties common to each.

_____

Task III Attached are sketches of a leaf. Describe three ways the growing leaf can be compared.

_____

_____

_____

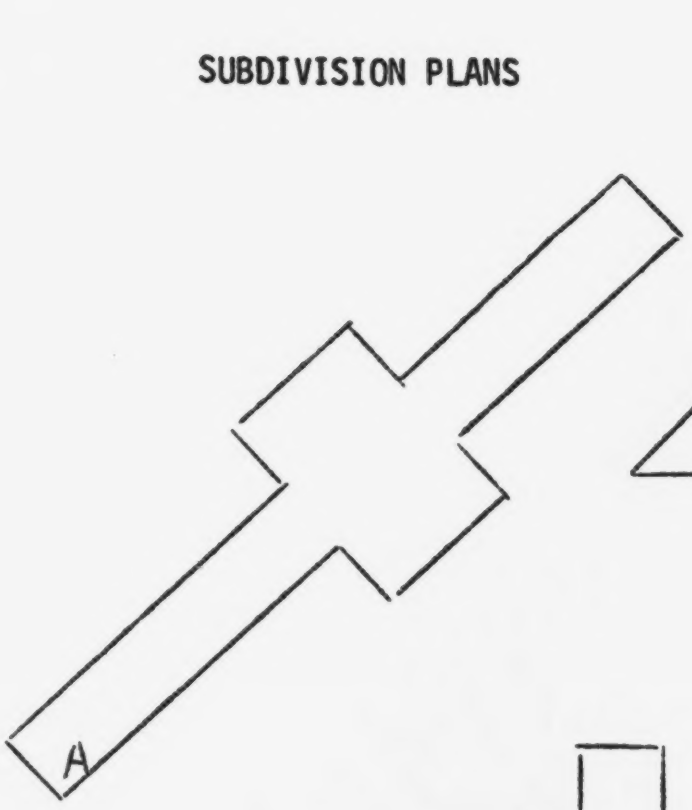
Task IV Describe the leaf at five weeks using the leaf at one week as a unit of comparison.

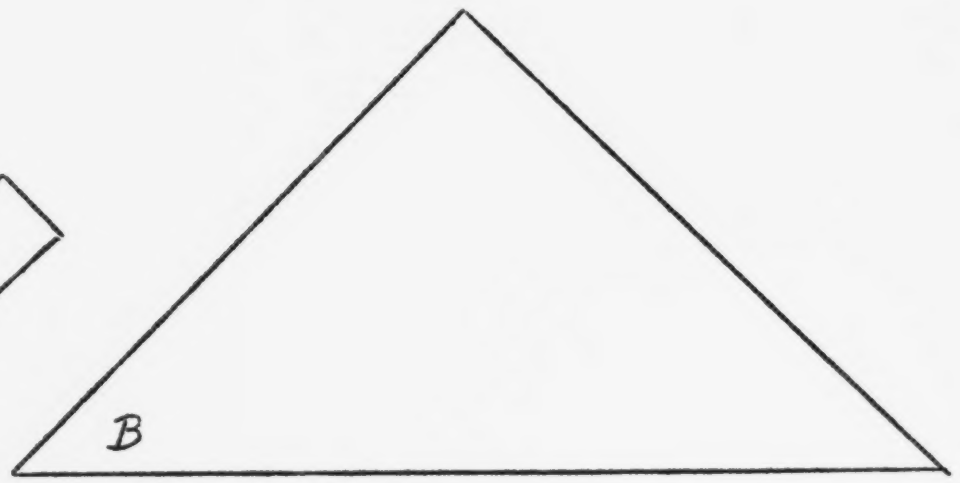
_____

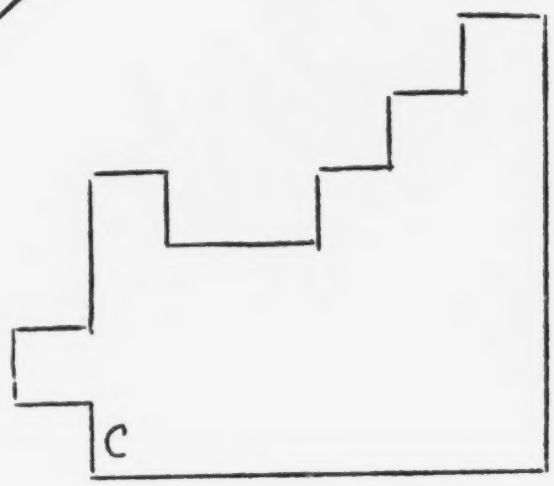
Task V. Describe the leaf at one week old using a standard unit of comparison.

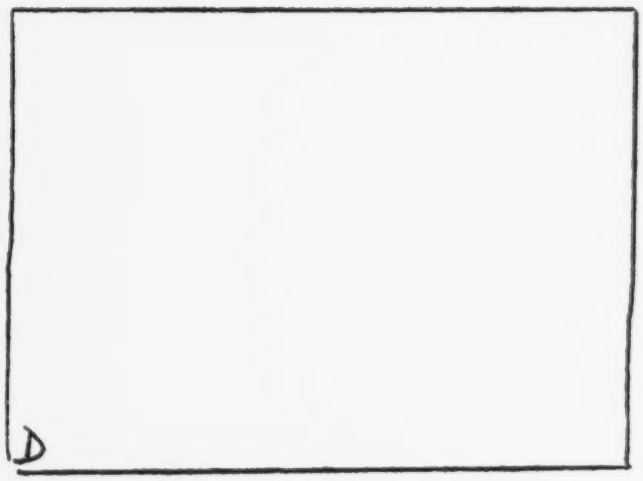
_____

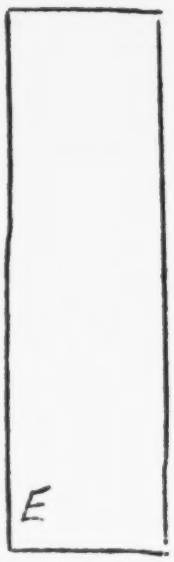
SUBDIVISION PLANS

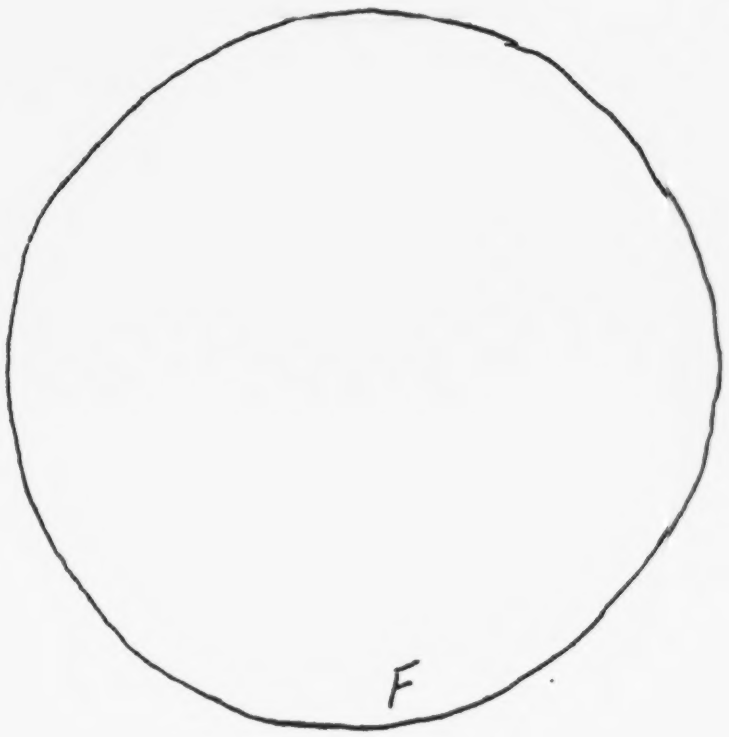


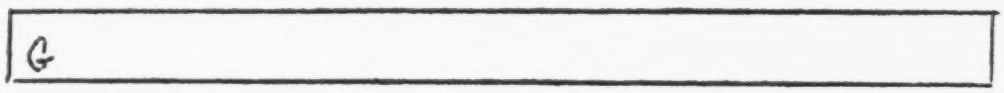




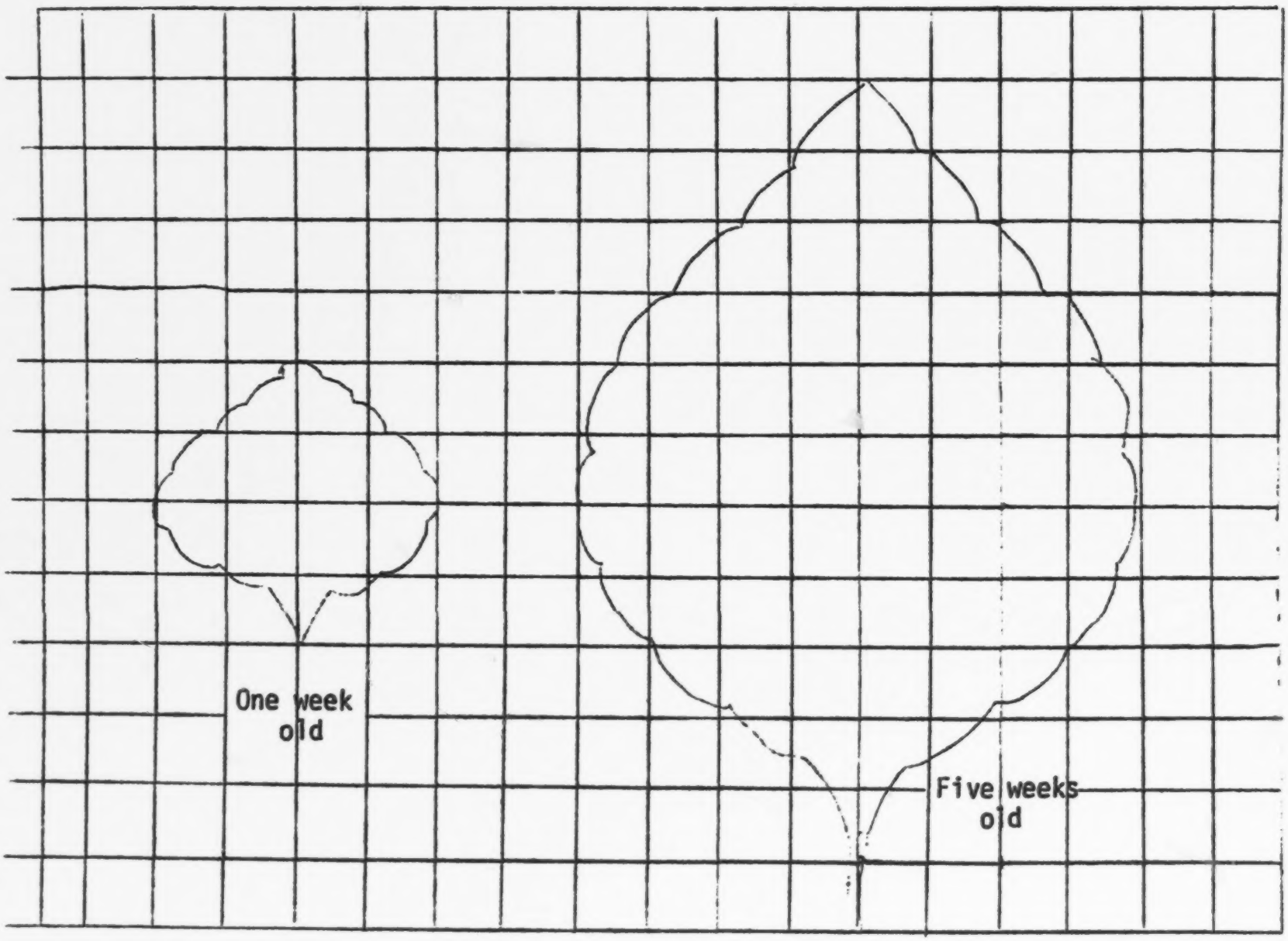






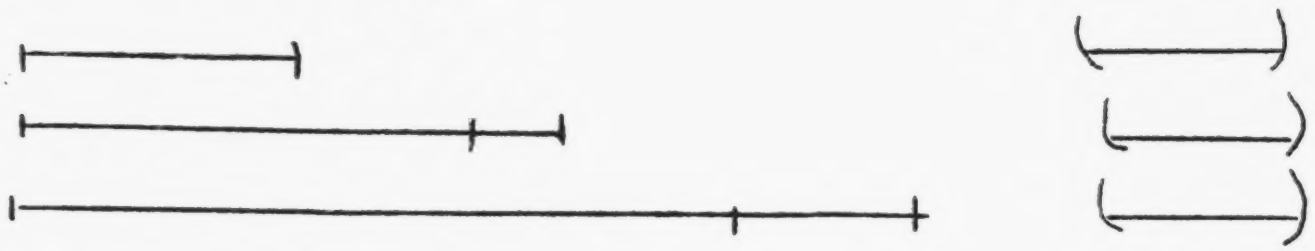


Here are two diagrams of a leaf at two different ages: one week and five weeks.

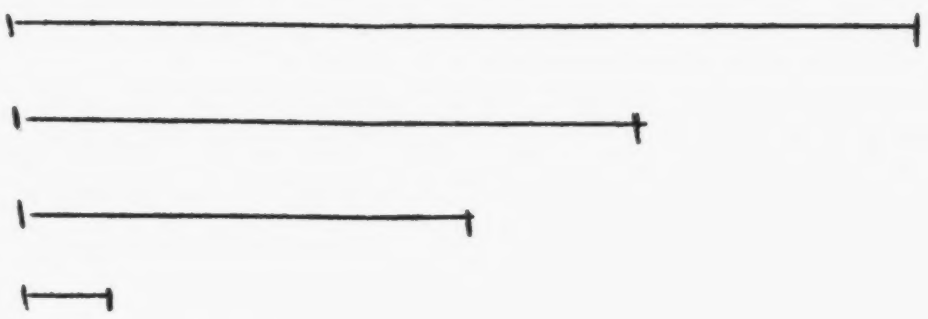


Task VI. Use only your pencil--no other tools.

The line above is 10 cm in length. Estimate the length of the following:



Which of these lines is closest to 8 cm in length? Draw a circle around it.



Comparing Observations

Overview of Process of Measuring
(Parts A, B, C, D. are taken from 1967 Xerox)

PART A (k, 1)

Measuring 1 - BEGINNING MEASURMENT - COMPARING LENGTHS

Objectives:

At the end of this exercise the child should be able to:

1. DEMONSTRATE the sorting of objects into sets in which all objects of one set are of equal length.

2. ORDER objects by length, from the shortest to the longest.

3. DISTINGUISH that one object is the same length as another object by showing that both are the same length as a third.

Context: Dowels and paper strips are matched and ordered by children on the basis of length.

Vocabulary: Fits side by side, same length, longer than, shorter than, next to, dowel.

PART B (1, 2)

Measuring 2 - LINEAR MEASUREMENT

Objectives:

At the end of this exercise the child should be able to:

1. DEMONSTRATE how many times a measuring stick can be laid end-to-end along a given length that is to be measured.

2. CONSTRUCT the explanation that when lengths are used to measure a given object, the results will be numerically different when measuring sticks of different lengths are used to measure a given object.

3. NAME the results of measurements that are not an exact number of stick-lengths. For example, if the object to be measured is between four and five measuring sticks, the following expressions are acceptable: "The object is more than four sticks"; "Four sticks and a little more"; "Between four and five sticks"; or other similar answers.

Context: Children measure many items in the classroom with a variety of centimeter measuring sticks.

Vocabulary: measure, measuring stick, unit.

Measuring 3 - COMPARING VOLUMES

Objectives:

At the end of this exercise the child should be able to:

1. ORDER containers by volume when relative volumes can be distinguished by inspection.

2. ORDER containers by volume, when ordering is not obvious by inspection, by pouring liquid or a finely divided solid (such as sand) from one container to another.

3. DEMONSTRATE a procedure for comparing the volume of containers in terms of unit volumes required to fill each container.

Context: Using sand and colored water, children compare volumes of a variety of bottles, jars, and space figures.

Vocabulary: volume, prism, unit of volume.

Measuring 4 - LINEAR MEASUREMENT USING METRIC UNITS

Objectives:

At the end of this exercise the child should be able to:

1. NAME three metric units of linear measure -- the centimeter, the decimeter, and the meter.

2. DEMONSTRATE how to select the appropriate metric measuring stick when asked to determine the length of an object.

3. DEMONSTRATE the procedure for finding the length of an object, and NAME the results in whole metric units or as between two whole number units.

4. DEMONSTRATE the approximate length of a centimeter, a decimeter, and a meter.

Context: Children use marked and unmarked measuring sticks to measure items in the classroom.

Vocabulary: centimeter, decimeter, meter, horizontal, vertical, between.

Measuring 5 - MAKING COMPARISONS USING A BALANCE

Objectives:

At the end of this exercise the child should be able to:

1. ORDER objects the weight of which differ appreciably, by lifting them and by comparing them on an equal-arm balance.

2. STATE THE RULE that one object is heavier than another because the earth-pull on that object is greater than it is on the other.

3. DEMONSTRATE how to compare the weight of small objects by counting the number of arbitrary units, such as paper clips, pins, or tacks, needed to balance the objects on an equal-arm balance.

4. DESCRIBE the results of his measurements, as in the following example: "The object weighs the same as six paper clips," or "The object weighs more than ten paper clips but less than eleven paper clips."

Context: A variety of objects of varying weights are used with the equal-arm balance.

Vocabulary: force, exert, push, pull, earth-pull, heavy, weigh, equal-arm balance, to balance.

Measuring 6 - ORDERING PLANE FIGURES BY AREA

Objectives:

At the end of this exercise the child should be able to:

1. ORDER groups of plane (two-dimensional) figures of various shapes and sizes from smallest to largest on the basis of area. He will do this by visual comparison, by superimposing one upon the other, and by comparison with some selected unit.

2. DEMONSTRATE a procedure for finding the area of plane figures in terms of some selected unit.

Context: Children use animal tracks and two dimensional paper shapes to compare areas; they use books, cardboard squares, and grid paper to measure areas of two dimensional shapes.

Vocabulary: area, comparing, ordering, matching, approximate.

Measuring 7 - SEEDS AND SEED GERMINATION

Objectives:

At the end of this exercise the child should be able to:

1. DEMONSTRATE a procedure for determining the increase in the size of seeds after they have been soaked in water.

2. DEMONSTRATE that the amount of water available to the seed determines whether or not a seed sprouts, and how quickly.

3. CONSTRUCT a table for observations made of seed growth.

Context: Using mung bean sprouts and lima beans soaked for varying time periods, children compare and record observations.

Vocabulary: germination, optimum (optional), mung beans.

PART C (2, 3)

Measuring 8 - MEASURING FORCES WITH SPRINGS

Objectives:

At the end of this exercise the child should be able to:

1. STATE A RULE that if an object does not move,

the forces acting upon it must be in balance.

2. STATE A RULE that attaching a weight to a spring increases the force pulling on the spring so that it stretches.

3. DEMONSTRATE with a spring whether two objects have the same or different weights.

Context: Using equal-arm balances and spring scales, children work with cylinders of various weights, balls, boxes, and other objects.

Vocabulary: scale, spring, force, weight, earth-pull, counterbalance.

Measuring 9 - ESTIMATIONS AND COMPARISONS USING THE METRIC SYSTEM

Objectives:

At the end of this exercise the child should be able to:

1. APPLY A RULE to estimate the linear dimensions of common objects in terms of centimeters, decimeters, or meters.

2. NAME a known object that is approximately the same length or width as another object.

Context: Children use metric measures for estimating and measuring items in their classroom.

Vocabulary: estimate, compare.

Measuring 10 - AN INTRODUCTION TO SCALES

Objectives:

At the end of this exercise the child should be able to:

1. DISTINGUISH between representations of objects that are life-size and those that are not.

2. IDENTIFY AND NAME the relationship between the actual size of an animal and its representation when the scale is given.

3. DEMONSTRATE the procedure of indicating scale by

drawing a line segment to represent a specific length.

Context: Using pictures of dinosaurs and other animals, children work with the concept of scale.

Vocabulary: scale, dinosaur, Diplodocus, Stegosaurus, realistic, life-size.

Measuring 11 - TEMPERATURE AND THERMOMETERS

Objectives:

At the end of this exercise the child should be able to:

1. IDENTIFY and NAME the temperature from his own arbitrary scale, from the Celsius (centigrade) seale, and from the Fahrenheit scale.

2. NAME the boiling and freezing points of water in both systems, and also the approximate normal body temperature.

Context: Children use home-made thermometers (plastic test tube, colored water, plastic tubing) and lab thermometers.

Vacabulary: Fahrenheit, Celsius (centigrade), degree, thermometer, temperature, expand, contract, interpolation.

Measuring 12 - MEASURING VOLUMES

Objectives:

At the end of this exercise the child should be able to:

1. DEMONSTRATE the measurement of the volume of a liquid using metric units and NAME the results in metric units.

2. DEMONSTRATE that the volume of a liquid remains constant as the liquid is transferred from one container to another.

Context: Using graduated cylinders, a variety of containers, medicine dropper, and pipette, children work with colored water.

Vocabulary: volume, liter, milliliter, graduated cylinder, pipette, beaker, meniscus.

PART D (3, 4)

Measuring 13 - DESCRIBING THE MOTION OF A REVOLVING PHONOGRAPH RECORD

Objectives:

At the end of this exercise the child should be able to:

1. DESCRIBE AND DEMONSTRATE how to measure the rate of revolution of a revolving disc in revolutions per unit of time (for example, revolutions per minute.)

2. DESCRIBE AND DEMONSTRATE how to measure the rate of revolution (in rpm) of objects located at different distances from the center of a disc.

3. DESCRIBE AND DEMONSTRATE how to measure the distance an object moves per unit of time (for example, decimeters per minute) when it is at different distances from the center of a revolving disc.

4. DESCRIBE AND DEMONSTRATE that the farther an object is located from the center of a revolving disc, the greater is its linear speed, although its rate of revolution is the same.

Context: Children use a cardboard disc marked with a bead, and a record player.

Vocabulary: records, record player, phonograph, turntable, revolution, revolve, revolutions per minutes(rpm) center, faster than, slower than.

Measuring 14 - MEASURING DROP BY DROP

Objectives:

At the end of this exercise the child should be able to:

1. DEMONSTRATE that the drop can be used as a unit of measure for finding the volumes of liquids.

2. DEMONSTRATE that drops of different liquids formed by the same dropper may have different volumes.

3. DEMONSTRATE that drops of the same liquid formed by droppers with tips of different sizes have different volumes (or sizes).

Context: Children use a medicine dropper of varying sizes, graduated cylinders and other containers of varying size, with colored water.

Vocabulary: meniscus, dilute.

Measuring 15 - MEASURING EVAPORATION OF WATER

Objectives:

At the end of this exercise the child should be able to:

1. DEMONSTRATE the rate of change in a given amount of liquid in measured units of weight, or volume, and time.

Context: Children place covered and uncovered pans of water and soaked fabric in a variety of locations to make comparative observations.

Vocabulary: evaporation, saturate.

Measuring 16 - DESCRIBING AND REPRESENTING FORCES

Objectives:

At the end of this exercise the child should be able to:

1. CONSTRUCT vectors to represent forces.
2. DESCRIBE changes in motion related to force.
3. IDENTIFY the forces causing motion, or lack of it, in simple situations.

Context: Children work with mounted springs and weights.

Vocabulary: horizontal diagonal, force, earth-pull, stationary, vertical, exert, balance, motion, vector.

Duplicated Materials - With Answers

CO #1

Code_____

Comparing Observations

Pre-Appraisal

Task I. Farmer Brown was planning to build a pen for his pigs. Some alternate plans for his pen are depicted on the following page.

Name two properties common to the pens.

LENGTH, WIDTH, AREA, PERIMETER, NUMBER OF ANGLES

Task II.

a. Order the pens on the basis of area.

F A B C D E

b. Draw the longest straight line possible inside each pen. Now order the pens on the basis of the lines you drew.

C B F E D A

Task III. Attached are sketches of a Mung Bean Plant. Describe three ways the developing plant can be compared on different days.

HEIGHT, WEIGHT, AREA

NUMBER OF LEAVES

AREA OF LEAVES

Task IV. Describe the plant on the fourth day, using its appearance on another day as a unit of comparison.

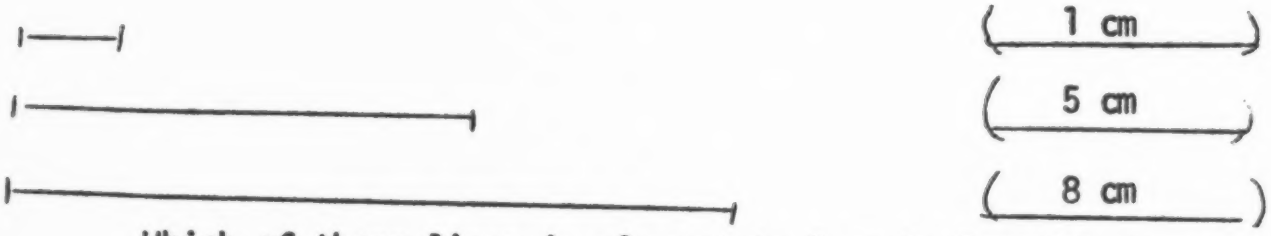
TWO TIMES AS TALL AS 3RD DAY PLANT; ONE HALF AS TALL AS 6TH DAY PLANT; SIX TIMES AS TALL AS 2ND DAY PLANT

Task Describe the plant on the seventh day using a standard unit of comparison.

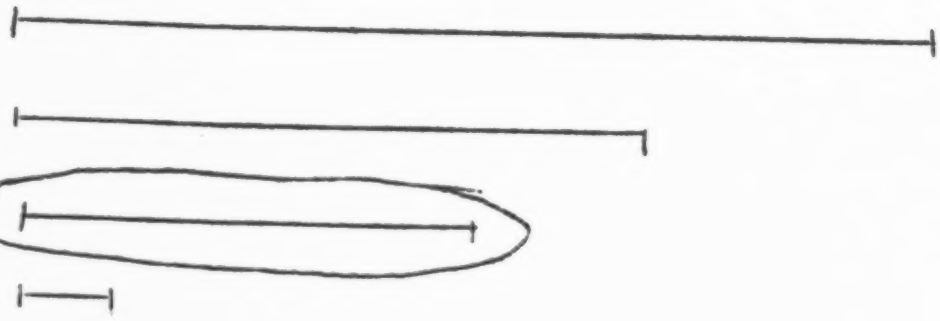
6-5/8 INCHES IN HEIGHT; 16-1/2 cm IN HEIGHT

Task VI Use only your pencil--no other tools.

The line above is 10 cm in length. Estimate the length of the following:



Which of these lines is closest to 5 cm in length? Draw a circle around it.



Use only your pencil--no other tools.

1. Estimate the width of this paper in cm.

21½ cm

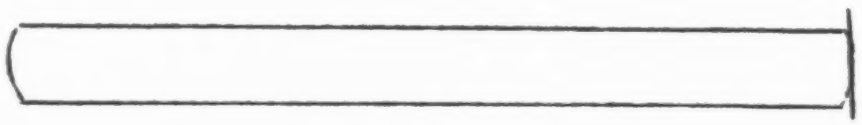
2. There are three types of film: 8 mm, 16 mm, and 35 mm. Mark these lines to show the width of each film.

8 mm

16 mm

35 mm

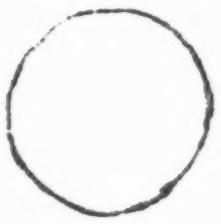
3. Advertisement is being made about the "silly millimeter" that is being added to cigarettes. Show how much longer this cylinder would be if a millimeter was added.



4. What is the length of your shoe in decimeters?

2-3 AVERAGE (LADY) SHOE

5. A rock hit an auto windshield and the crack spread out in all directions from the point of impact about 2 cm from the center. Draw a circle the size of the cracked area of the windshield.



CO #3

Code_____

Comparing Observations

Appraisal

Task I. A contractor was planning to subdivide a new area of the county. Some alternate plans for his subdivision appear on the following page.

a. Order the tracts on the basis of the amount of area of each tract.

G E A C B D F

b. Draw the longest straight line possible inside each tract. Now order the tracts on the basis of the lines you drew.

E C F D A B G

Task II. Attached are sketches of a leaf. Name two properties common to each.

HEIGHT, WIDTH, AREA, AGE

Task III Attached are sketches of a leaf. Describe three ways the growing leaf can be compared.

HEIGHT, WIDTH

AREA

AGE

Task IV. Describe the leaf at five weeks using the leaf at one week as a unit of comparison.

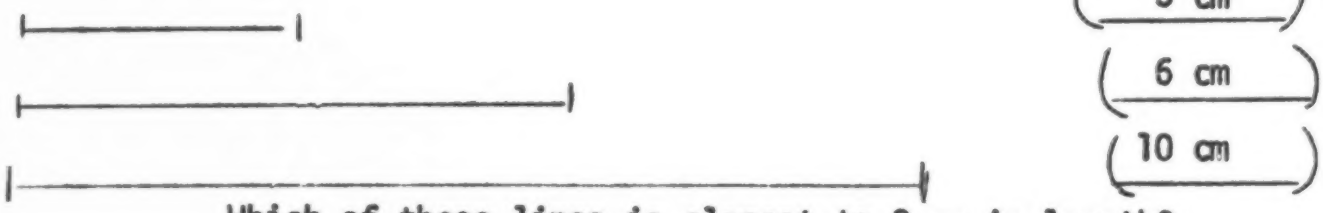
THREE TIMES HEIGHT OF ONE WEEK; TWO TIMES WIDTH OF ONE WEEK; SIX TIMES AREA OF ONE WEEK; FIVE TIMES OLDER IN AGE.

Task V. Describe the leaf at one week old using a standard unit of comparison.

4 cm TALL; 4 cm WIDE

Task VI. Use only your pencil--no other tools.

The line above is 10 cm in length. Estimate the length of the following:



Which of these lines is closest to 8 cm in length?
Draw a circle around it.